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Explanatory accompanying text for Poster:

Tailoring Wettability and Surface Energy of Textiles by DCSBD Plasma for Design-Oriented Applications

The presented research is focused on the preparation and characterization of biodegradable composite materials based on the combination of textile substrates, starch-based bioplastic, and newspaper layers modified by diffuse coplanar surface barrier discharge (DCSBD) plasma. The study investigates the influence of atmospheric plasma treatment on selected surface and functional properties of textile materials intended for the preparation of lightweight composite structures.

Four different textile substrates with varying structural and material characteristics were experimentally investigated, including cotton satin with atlas weave, linen-viscose plain weave fabric, cotton knitted fabric containing elastane, and polyester tulle. These materials were selected due to their different porosity, surface morphology, flexibility, and expected interaction with the prepared starch-based bioplastic matrix. Newspaper paper was additionally incorporated into the resulting composite system as a secondary biodegradable layer.

Prior to composite preparation, all selected materials were treated using atmospheric DCSBD plasma generated at a power of 400 W. Plasma treatment was applied dynamically from both sides of the textile substrates in order to achieve more uniform surface activation. The prepared bioplastic consisted of potato starch, glycerol, water, and acetic acid, forming a transparent viscoelastic matrix suitable for bonding textile and paper layers into composite structures.

Experimental evaluation included the analysis of capillary rise, absorbency, porosity, wettability, and surface free energy of investigated textile materials before and after plasma treatment. Contact angle measurements using distilled water and diiodomethane were performed and subsequently evaluated using the OWRK method for determination of surface free energy and its polar and dispersive components. Additional analyses included FTIR-ATR spectroscopy, testing of surface wetting resistance, colour fastness evaluation, and accelerated ageing under combined UV radiation and humidity exposure.

The obtained results confirmed that DCSBD plasma significantly modified the surface behavior of the investigated materials. Plasma-treated samples exhibited improved wettability and increased surface free energy, particularly in the case of woven textile substrates. The influence of textile structure and porosity on plasma interaction and bioplastic penetration was also observed. Experimental observations further indicated differences in the drying behavior of prepared composites, where plasma-modified structures showed faster drying compared to untreated reference samples.

The research demonstrates the potential of atmospheric DCSBD plasma for environmentally friendly surface modification of textile materials intended for biodegradable composite applications. The combination of renewable raw materials, atmospheric plasma treatment, and experimentally prepared composite structures represents a promising approach for the development of sustainable material systems with functional and visually distinctive characteristics.